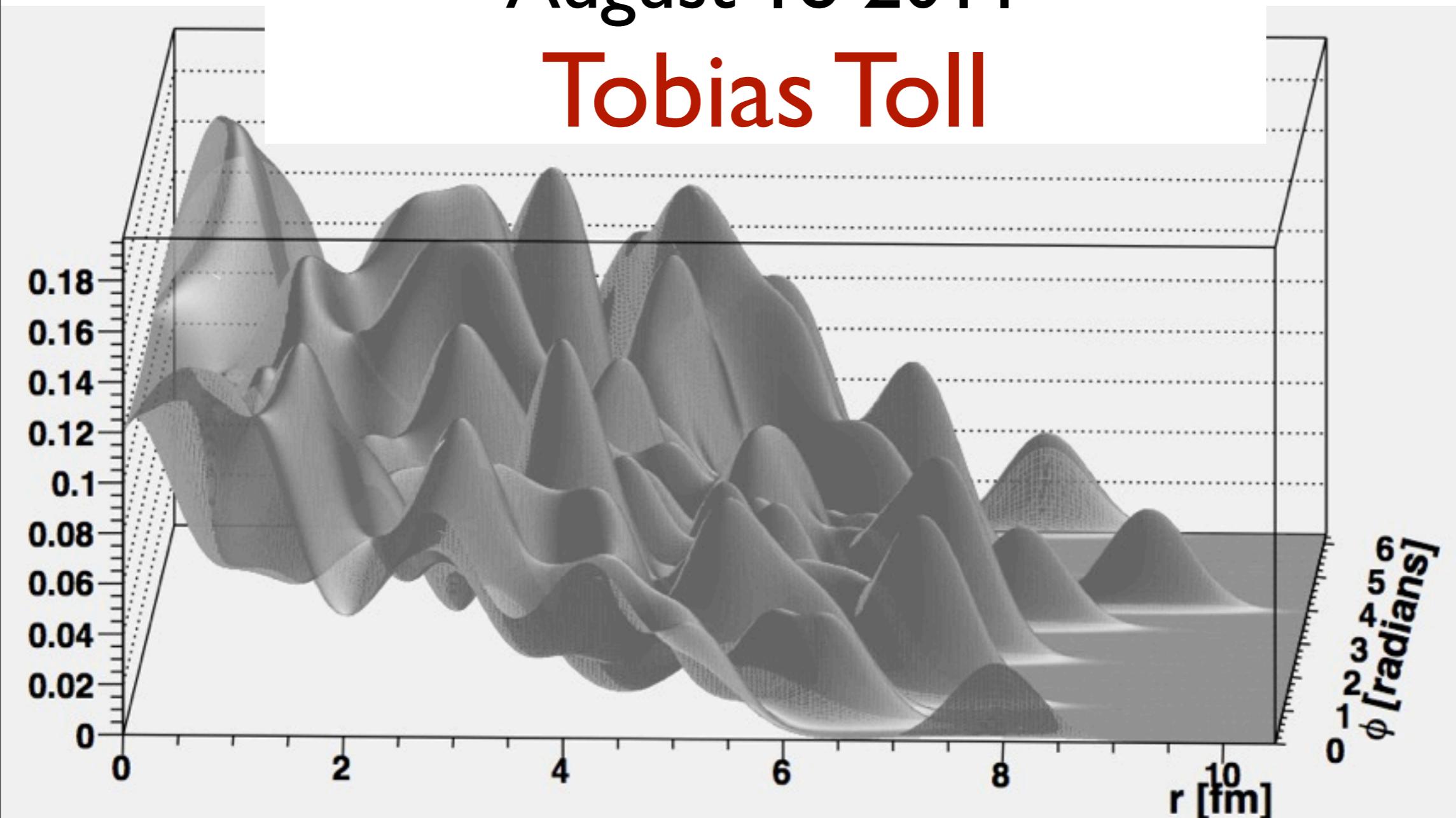


An update on the progress of Sartre

EIC TF meeting
August 18 2011

Tobias Toll



What has been done since DIS

Changed integration algorithm from Root to Cuba (Cuhre)

Rewritten the code into two separate parts:

- I) All the (very) complicated calculations are saved into tables of $\langle A \rangle$ and $\langle A^2 \rangle$. Slow!!
- 2) The generator read in these tables using an interpolation routine producing the cross-sections. Fast!
For the user.

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Reminder: the (very) complicated parts

$$\frac{d\sigma_{\text{total}}}{dt} = \frac{1}{16\pi} \left\langle |\mathcal{A}|^2 \right\rangle_{\Omega}$$

$$\frac{d\sigma_{\text{coherent}}}{dt} = \frac{1}{16\pi} |\langle \mathcal{A} \rangle_{\Omega}|^2$$

Define average:

$$\langle \mathcal{O} \rangle_{\Omega} \approx \frac{1}{C_{\max}} \sum_{j=1}^{C_{\max}} \mathcal{O}(\Omega_j)$$

$$\mathcal{A}(\Omega_j) = \int dr \frac{dz}{4\pi} d^2\mathbf{b} (\Psi_V^* \Psi)(r, z) 2\pi r b J_0([1-z]r\Delta) e^{-i\mathbf{b}\cdot\Delta} \frac{d\sigma_{q\bar{q}}}{d^2\mathbf{b}}(x, r, \mathbf{b}, \Omega_j)$$

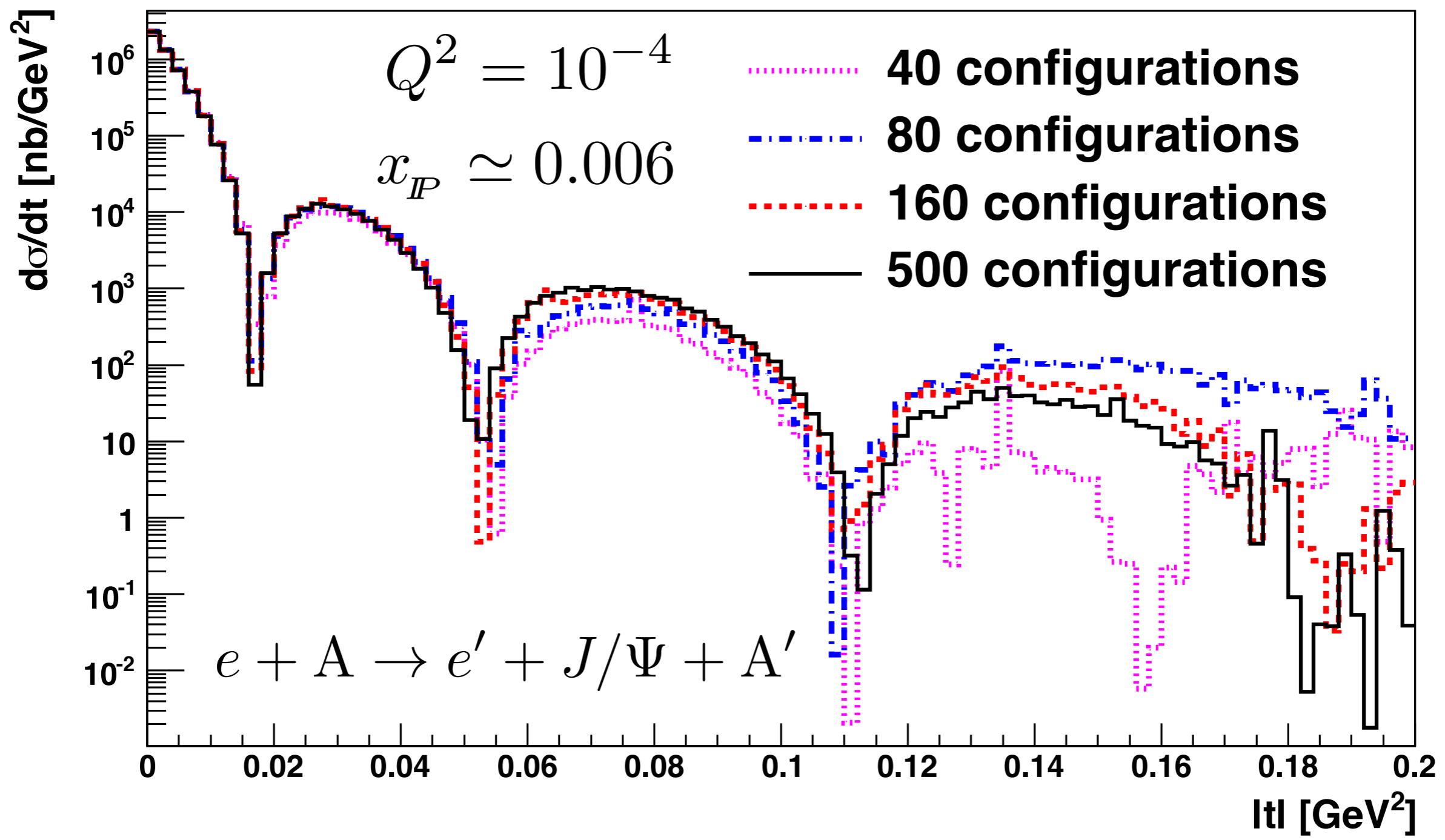
4 four-dimensional integrations for each phase-space point and configuration

Re, Im, L, T

How many configurations???

Convergence of sum:

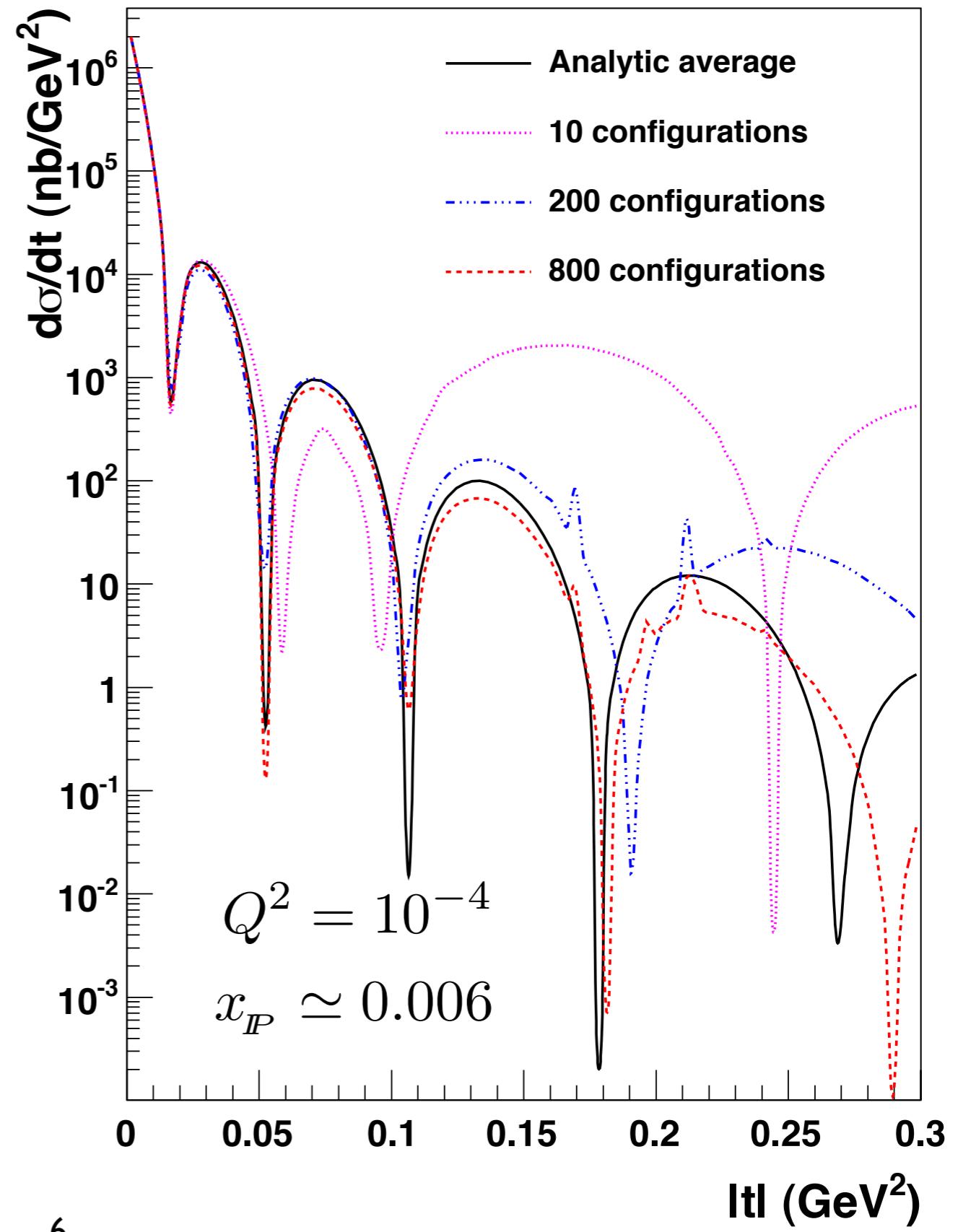
Root integration:



Convergence of sum:

Cuba integration:

Need 1000 configurations
to describe 5th minimum!!



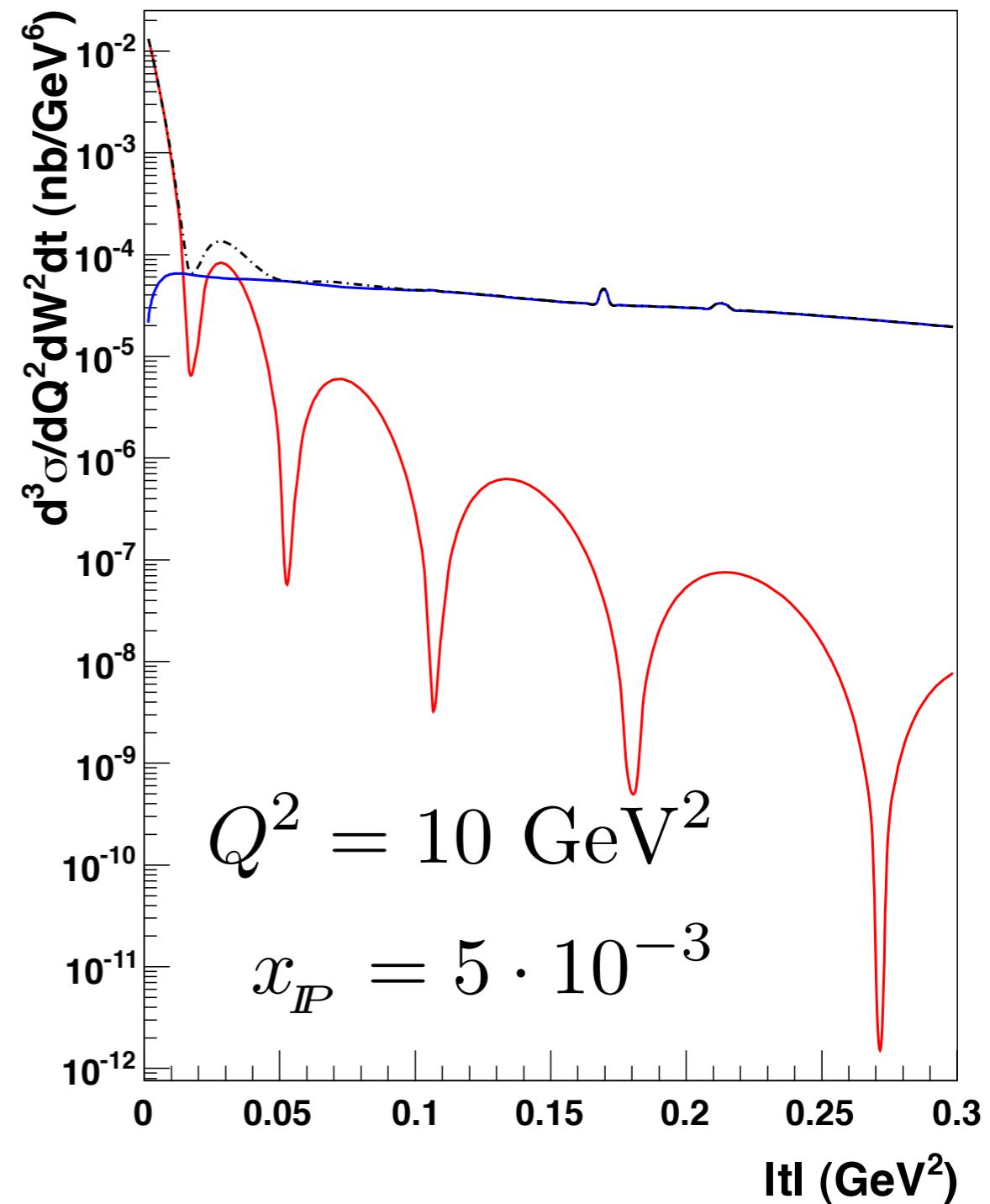
Convergence of sum:

Problem with convergence
of distribution:

Average (coherent)

<<<<

Variance (incoherent)



Convergence of sum:

Problem with convergence
of distribution:

Average (coherent)

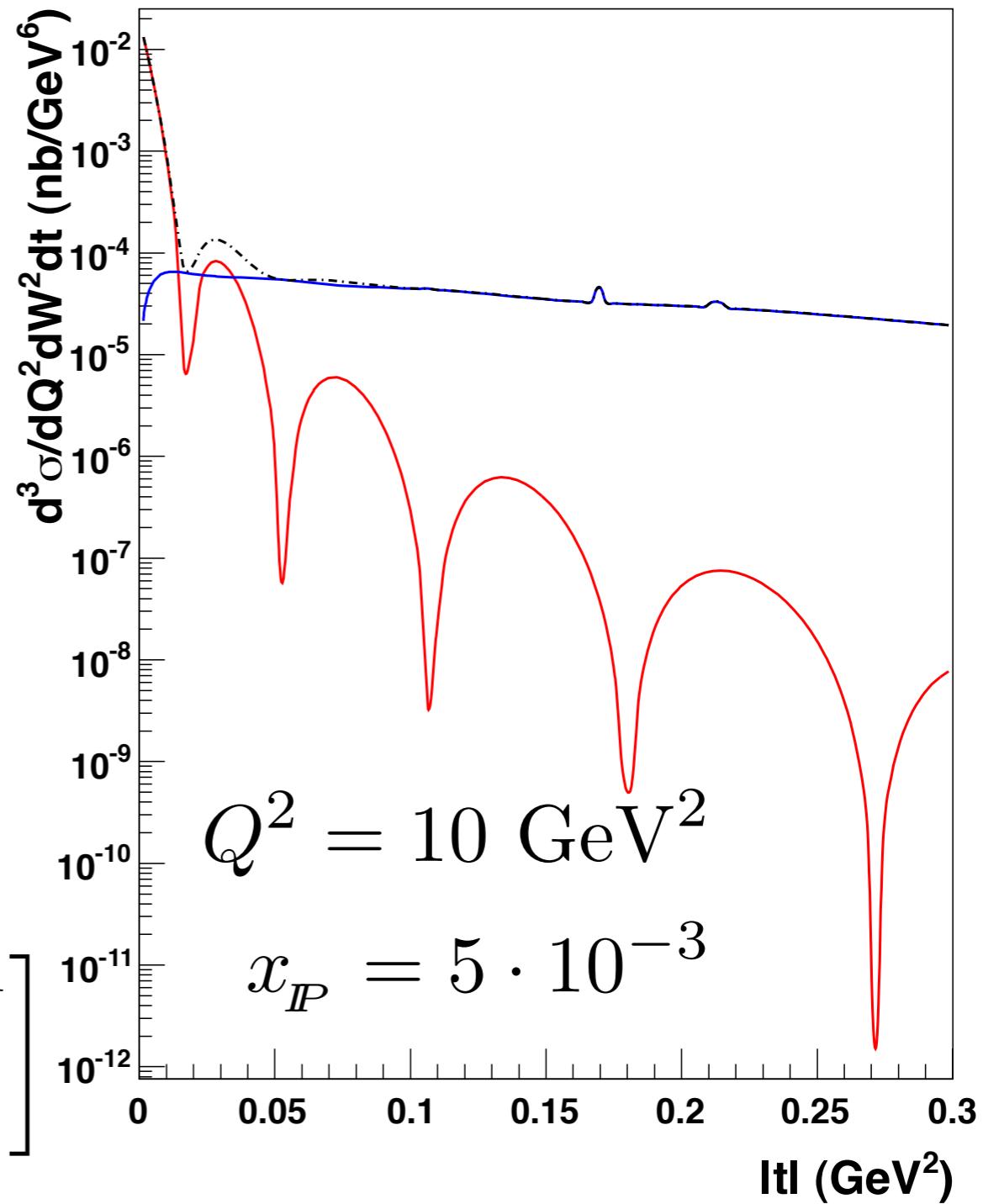
<<<<

Variance (incoherent)

Solution

Calculate the average from:

$$\left\langle \frac{d\sigma_{q\bar{q}}}{d^2 b} \right\rangle_\Omega = 2 \left[1 - \left(1 - \frac{T_A(b)}{2} \sigma_{q\bar{q}}^{(p)} \right)^A \right]$$



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For the user.

Lookup tables

3-dimensional: Q^2, W^2, t Independent of s

Four tables to create a cross-section point:

$$|\langle A_T \rangle|^2, |\langle A_L \rangle|^2, \langle |A_T|^2 \rangle, \langle |A_L|^2 \rangle,$$

$$\frac{d^3\sigma}{dQ^2 dW^2 dt} = f_T^\gamma \langle |A_T|^2 \rangle + f_L^\gamma \langle |A_L|^2 \rangle$$

Transverse if: $\frac{f_T^\gamma \langle |A_T|^2 \rangle}{f_L^\gamma \langle |A_L|^2 \rangle} > R$

Breakup if: $\frac{|\langle A_T \rangle|^2 - \langle |A_T|^2 \rangle}{|\langle A_T \rangle|^2} > R_{10}$

Lookup tables

3-dimensional: Q^2, W^2, t

Four tables to create a cross-section point:

$$|\langle A_T \rangle|^2, |\langle A_L \rangle|^2, \langle |A_T|^2 \rangle, \langle |A_L|^2 \rangle,$$

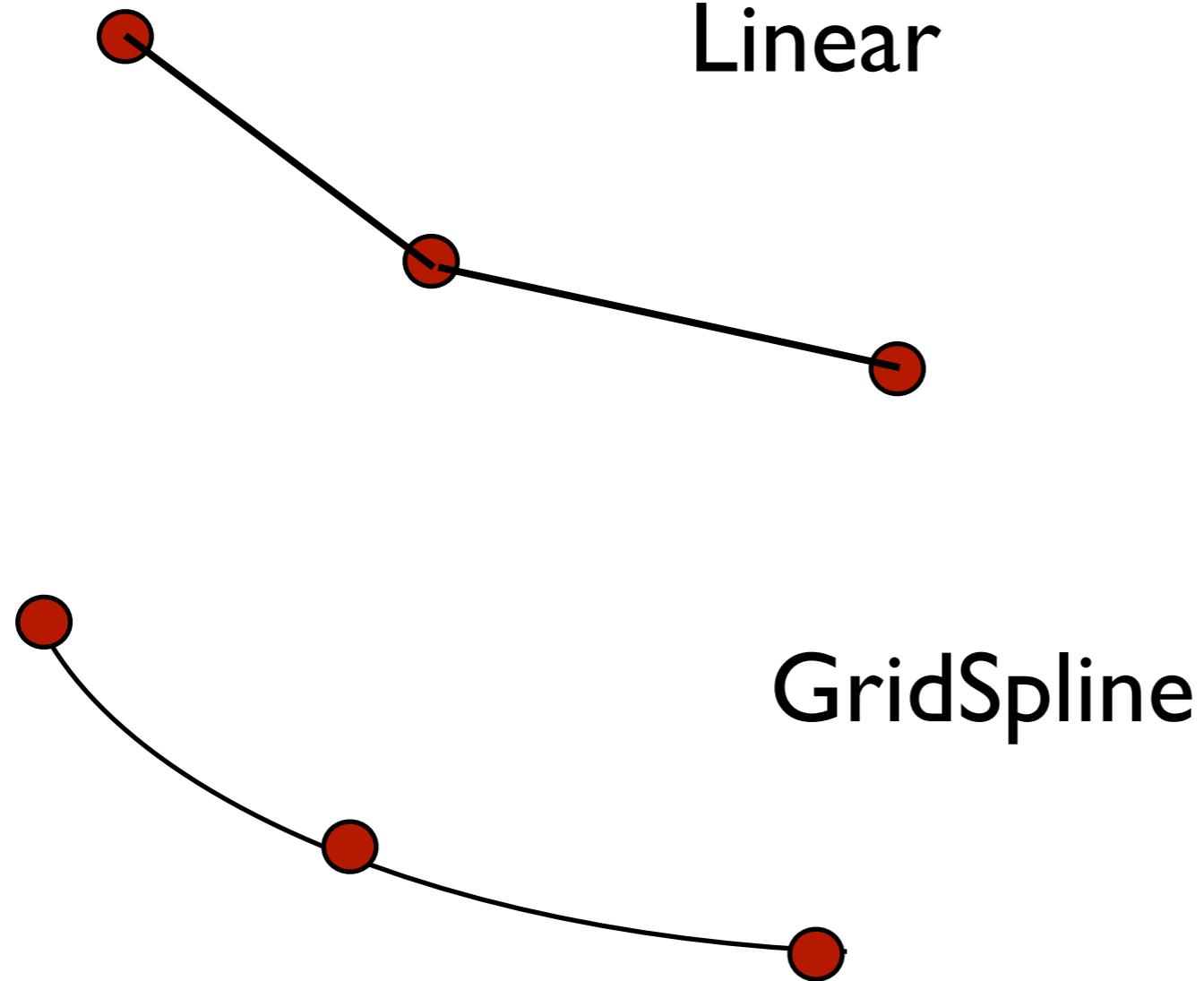
For better interpolation the logarithm of the values is stored in the tables

(linear interpolation -> exponential interpolation)

To enhance the interpolation further the s.c. GridSpline interpolation is used

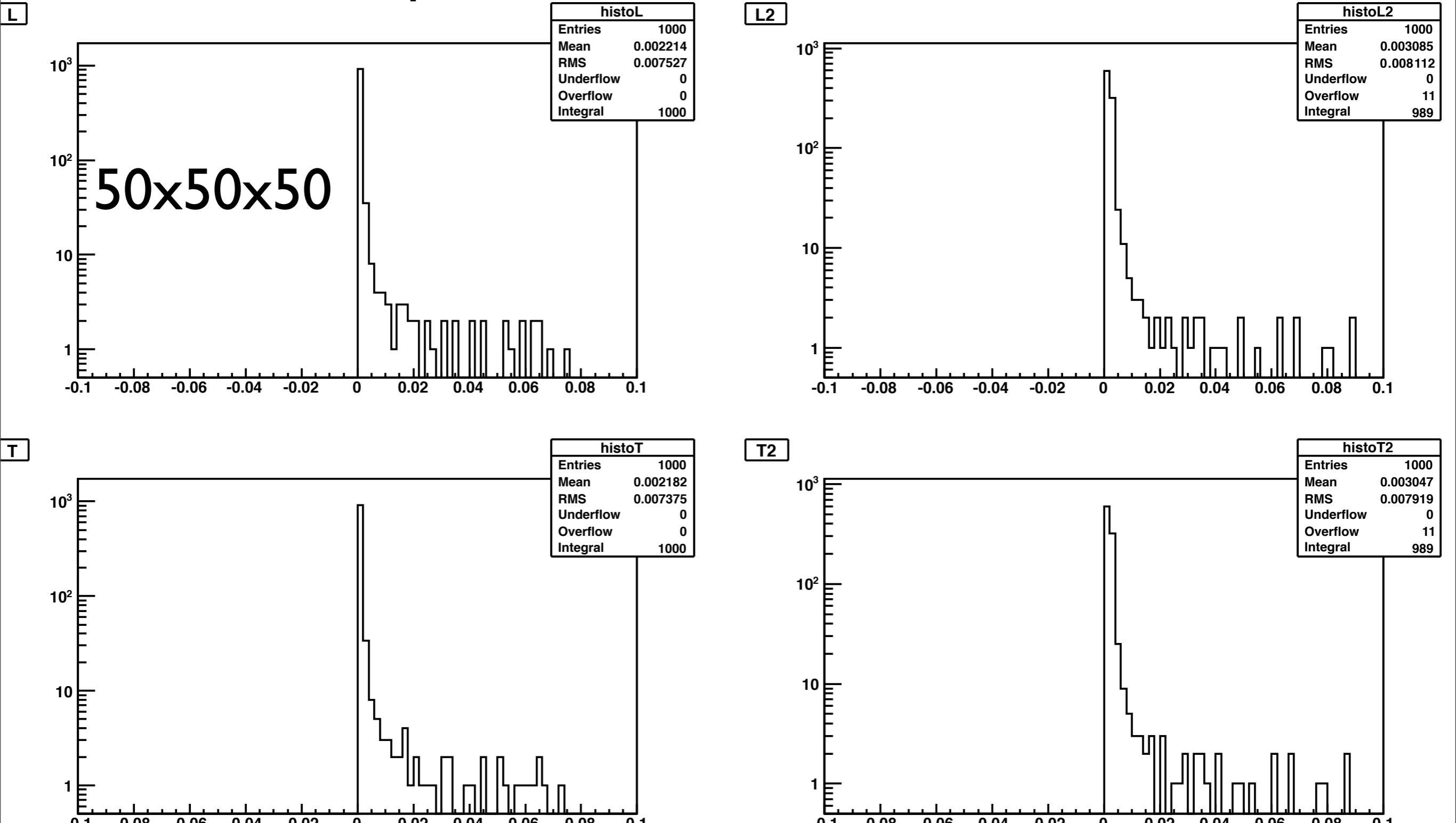
Takes up to +/- 4points in each direction and fit a polynomial through the points

Lookup tables



Interpolation: Linear (true-interpolation)/true

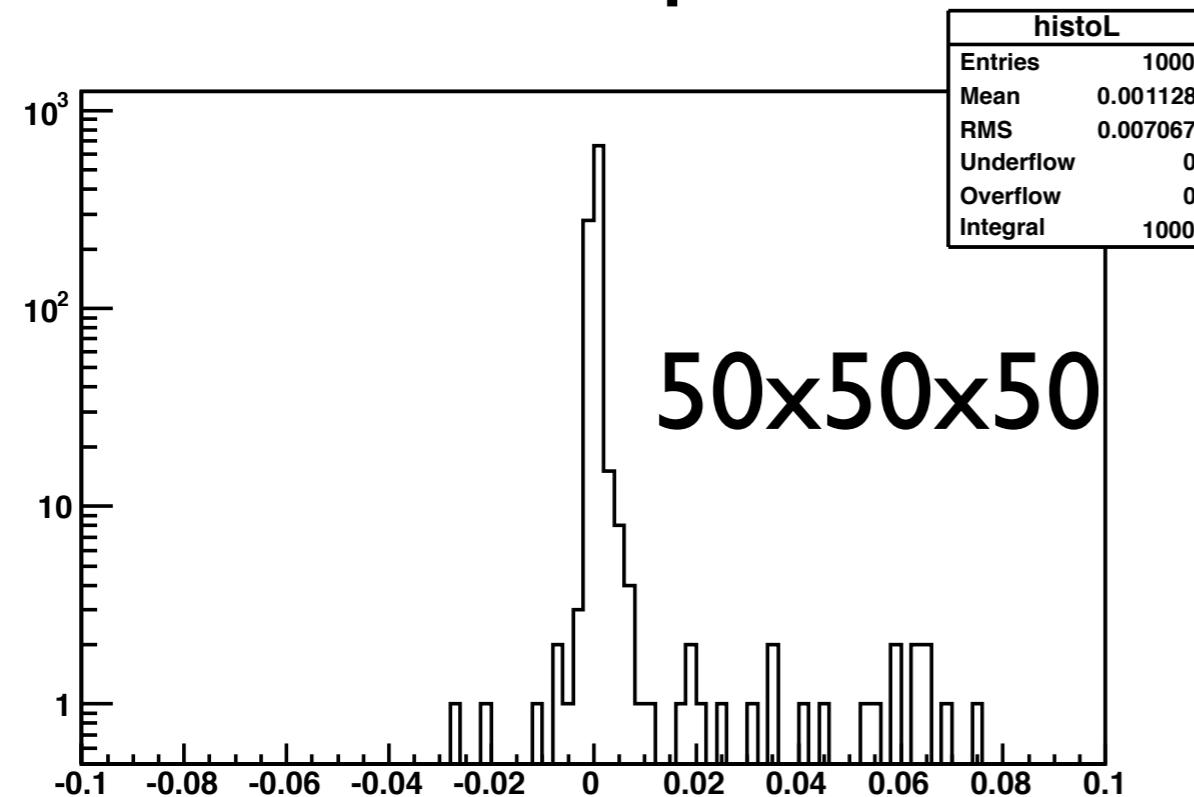
1000 random points $0.15 < Q^2 < 100$, $30 < W < 220$, $|t| < 1$



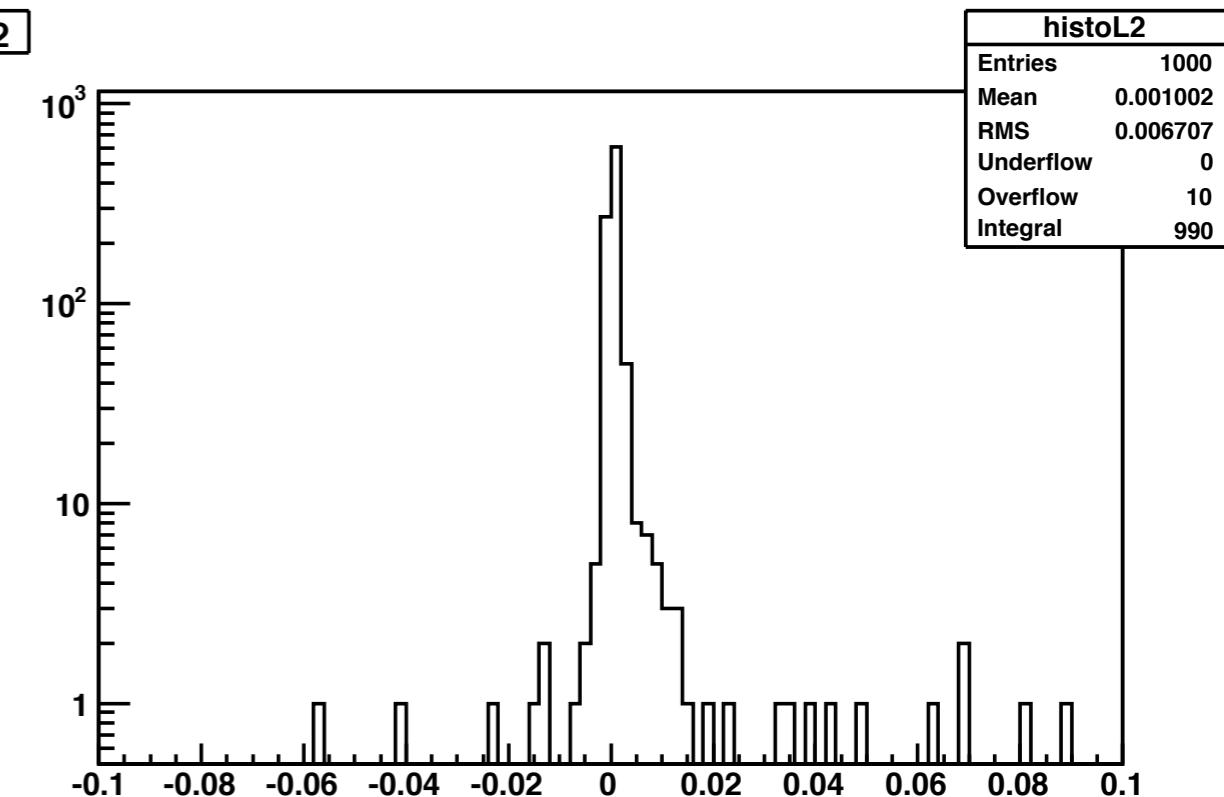
Interpolation: GridSpline (true-interpolation)/true

1000 random points $0.15 < Q^2 < 100$, $30 < W < 220$, $|t| < 1$

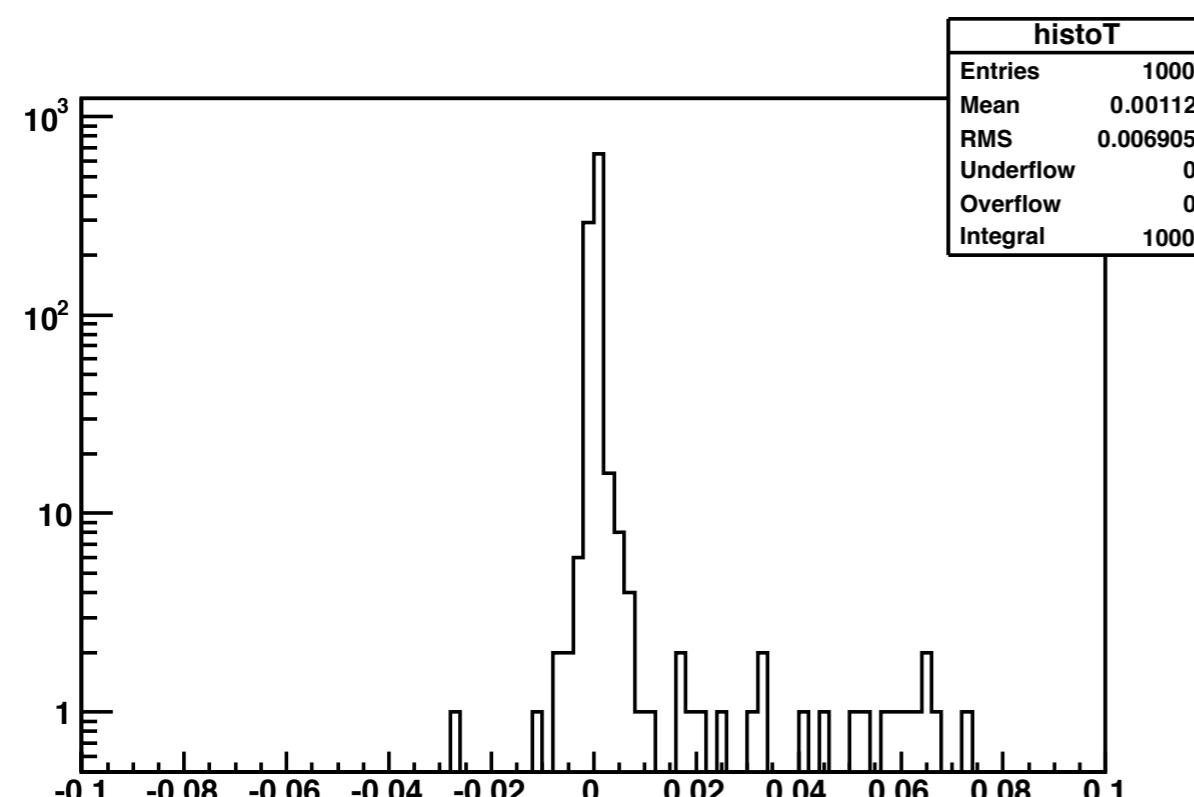
L



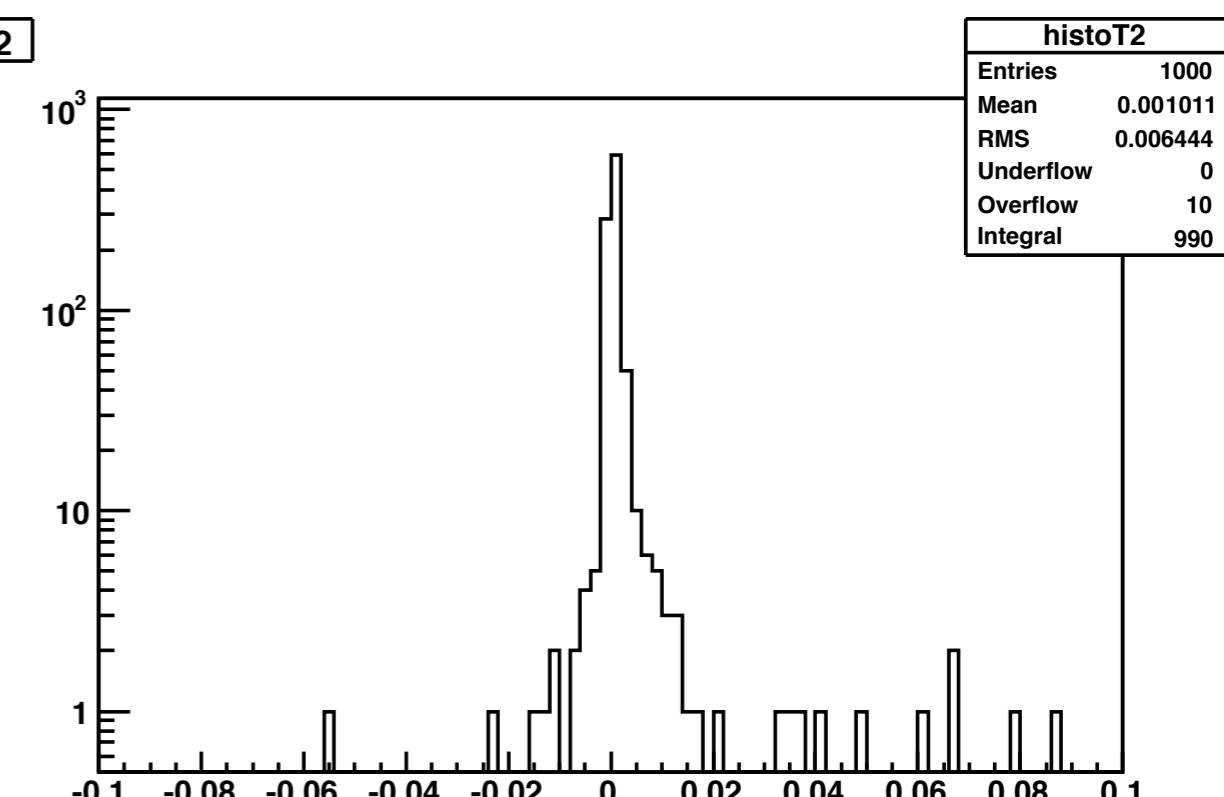
L2



T



T2



14

Producing and testing tables

in $e\bar{p}$

Granularities of $e\bar{p}$ -tables

using GridSpline interpolation and integrating over whole
tables:

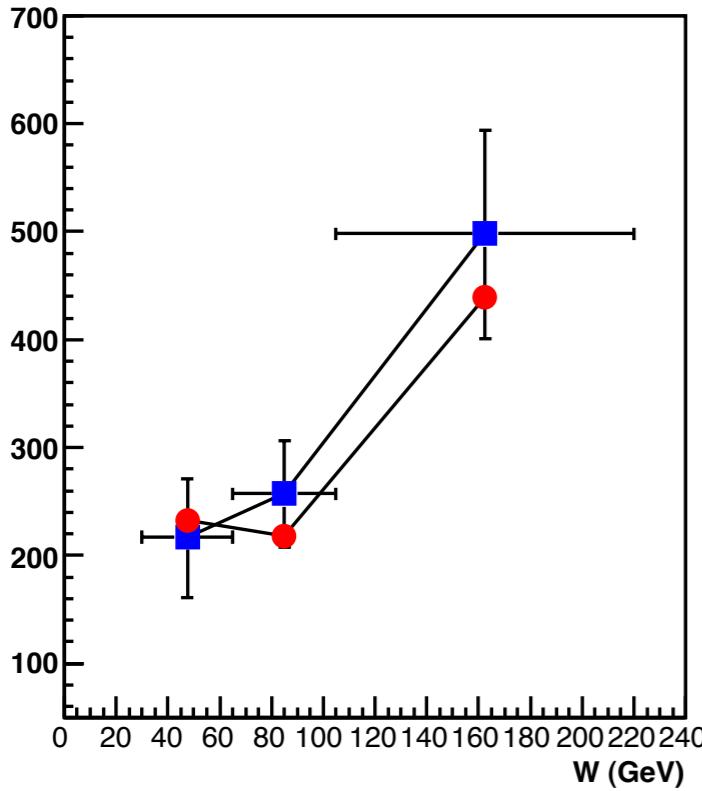
Bin Q2xW2xt	T2	L2	T	L	%T2	%L2	%T	%L
10x10x10	2.65933	1.17714	1643.68	1554.68	1.730199	2.482297	1.434781	1.852603
50x10x50	2.69823	1.20388	1662.07	1577.94	0.292733	0.267078	0.332003	0.384192
20x20x20	2.70164	1.2044	1665.09	1580.77	0.166724	0.224	0.150905	0.205533
30x30x30	2.703542	1.205556	1,666.21	1,582.45	0.09644	0.1282	0.083503	0.099664
40x40x40	2.705987	1.20713	1,667.49	1,583.96	0.006105	0.002161	0.006866	0.004274
50x50x50	2.706152	1.207104	1,667.61	1,584.03				

$$0.15 < Q^2 < 100, \quad 30 < W < 220, \quad |t| < 1$$

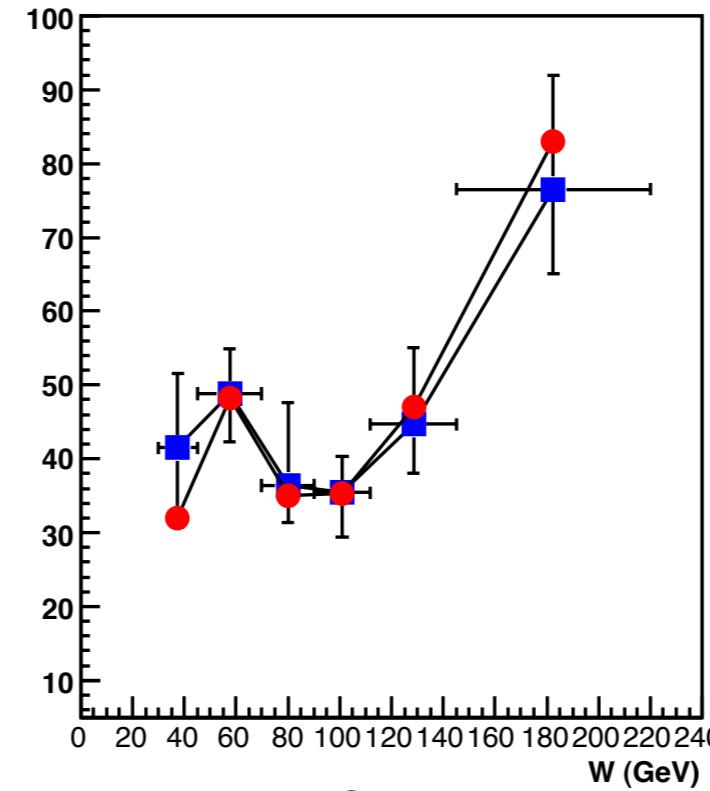
Running Sartre

Rereproducing HERA data:

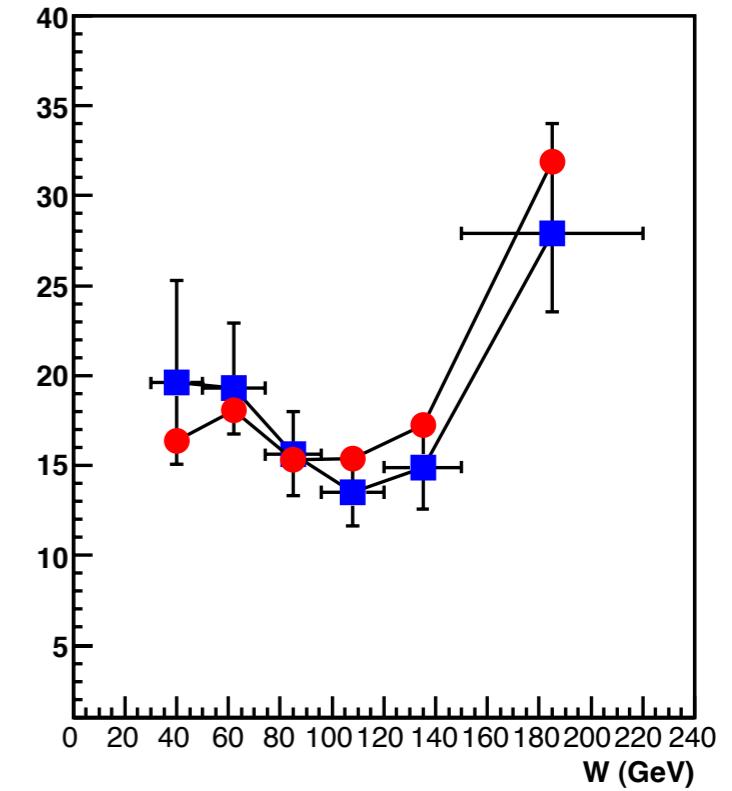
$0.15 < Q^2 < 0.8$



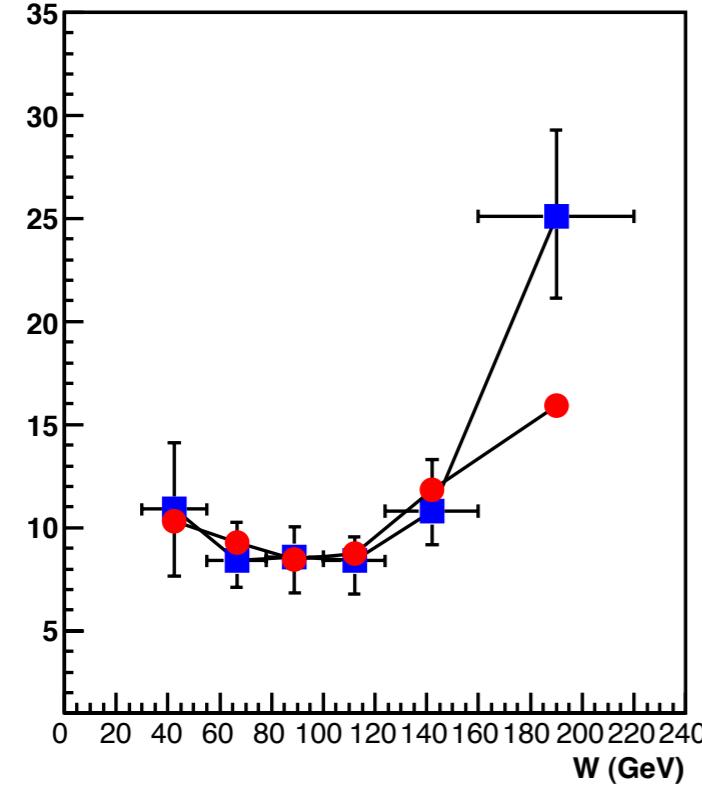
$2 < Q^2 < 5$



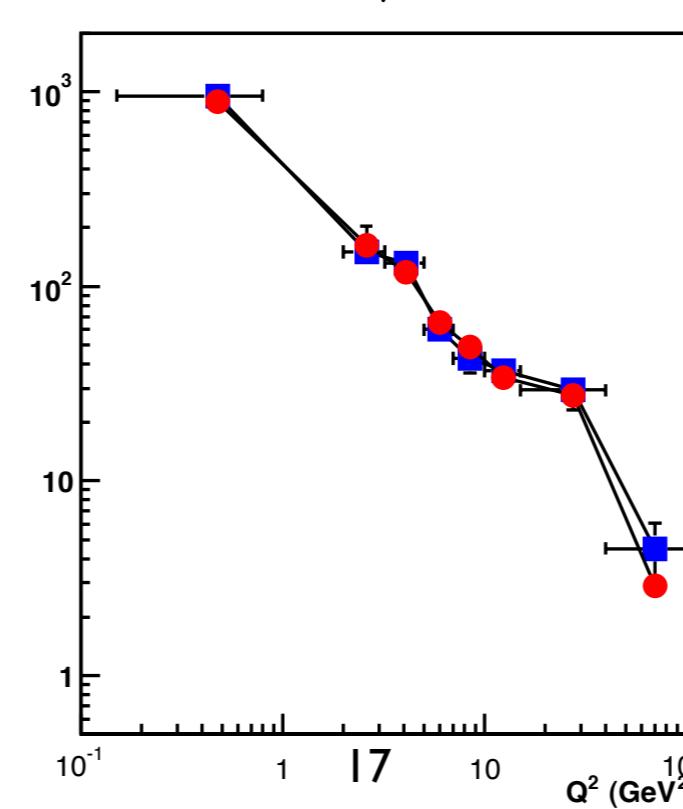
$5 < Q^2 < 10$



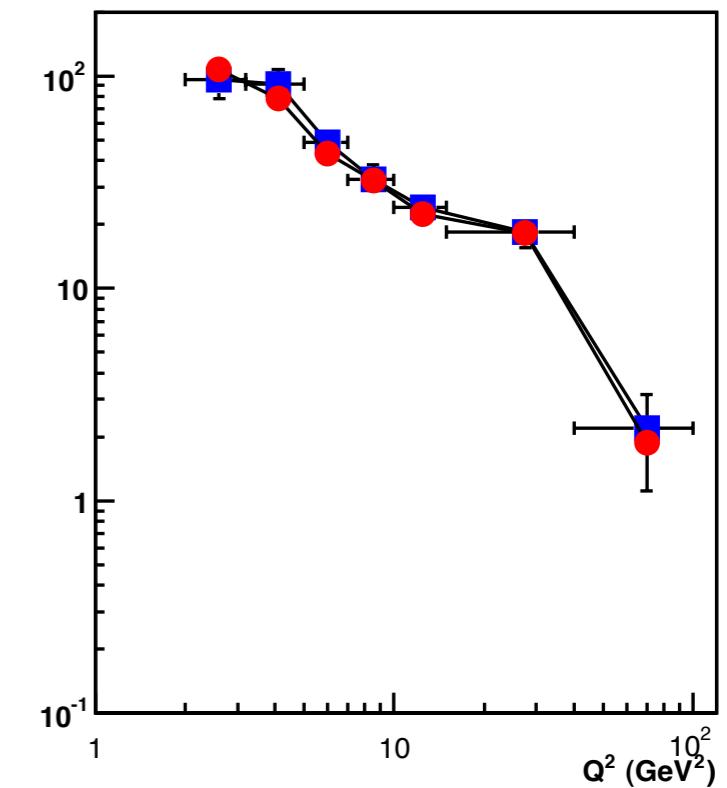
$10 < Q^2 < 100$



$30 < W < 220$



$45 < W < 160$



$$\chi^2/\text{ndf} = 0.5$$

What's next

Produce Nuclear tables:

Needs **~50x50x50 bins** averaged over
400 configurations

A few nuclear species
3 vector mesons

**Estimated computer time needed on one core on
my MacBook:**

What's next

Produce Nuclear tables:

Needs **~50x50x50 bins** averaged over
400 configurations

A few nuclear species
3 vector mesons

Estimated computer time needed on one core on
my MacBook:
~125 years

What's next

Produce Nuclear tables:

Needs ~50x50x50 bins averaged over
400 configurations

A few nuclear species
3 vector mesons

Estimated computer time needed on one core on
my MacBook:
~125 years

We have obtained an OSG certificate, which means that
we can parallelize all the red calculations.
Grid time estimate: a week

What's next

Learn how to use the grid

Produce tables

Testingtestingtesting

Publish